"Salt of the Earth Project: Integrating biogeomorphological insights from the Venice Lagoon for resilient coastal systems and sustainable management strategies"

Proposers: Prof. Andrea D'Alpaos

Summary: Coastal ecosystems such as **salt marshes**, **seagrass meadows** and **mangrove forests** (Figure 1) are simultaneously some of the **most socio-economically relevant and vulnerable ecosystems on Earth.** Providing a multitude of valuable ecosystem services, they remain in peril due to the intertwined effects of **climate change and increasing human pressure**.

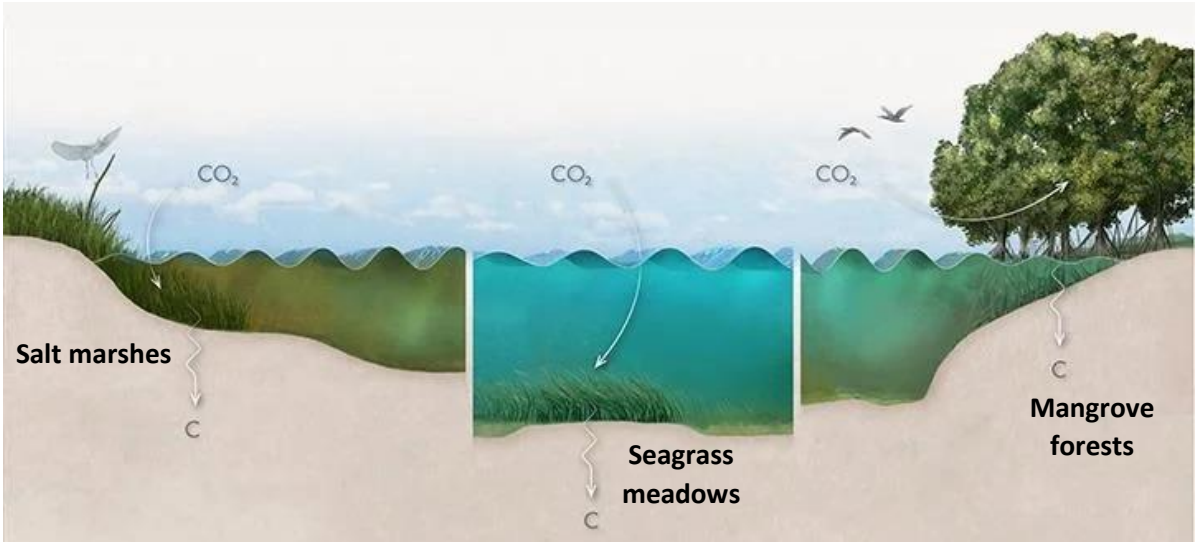

Figure 1. Salt marshes, seagrass meadows and mangrove forests are called Blue Carbon Ecosystems because they serve as efficient natural carbon sinks, thus helping to offset CO_2 emissions and fight climate change.

Salt of The Earth Productions Ltd. will fund this PhD project, focusing on **Venice and its lagoon** as a **prime example of the complex interaction between humans and nature**, and the evolving relationship between the environment and urban development. Coastal cities are vital centers of human activity but increasingly face threats from climate change and the need for flood protection. **Venice stands out as an urgent case**—both a warning and a testing ground for the future of coastal cities. Protected by the **MoSE** barrier system, Venice is shielded from sea-level rise and tides. Yet this system also disrupts the lagoon's morphology, **accelerating the degradation of salt marshes**—key to biodiversity and ecological balance.

Aim of the PhD project. In this PhD project we aim at describing the dynamics of tidal landforms in the Venice Lagoon and in other tidal systems worldwide. An important question that needs to be addressed is **"How will tidal landforms and ecosystems respond to, and their ecosystem services be affected by, climate changes and human interferences?"** This is an issue is of the utmost importance, both from a theoretical and practical point of view, for the great morphological, ecological, social, and economic value of blue carbon ecosystems.

Despite a number of studies have addressed the biogeomorphic response of tidal landforms to changes in the environmental forcing and to human activity, most of these studies have been carried out within separate disciplines. **This project aims at developing** an **innovative, integrated, interdisciplinary approach** that combines hydrodynamic, geomorphological, ecological, and sedimentological analyses, carried out through **direct field observations**, **remote sensing, laboratory analyses** and **numerical modelling**. Our research will focus on **innovative strategies** to enhance the resilience of

coastal cities and of the ecosystems which host them. This integrated approach not only focuses on strengthening human infrastructure, but places particular emphasis on harmonizing human needs with the conservation of marine and coastal ecosystems.

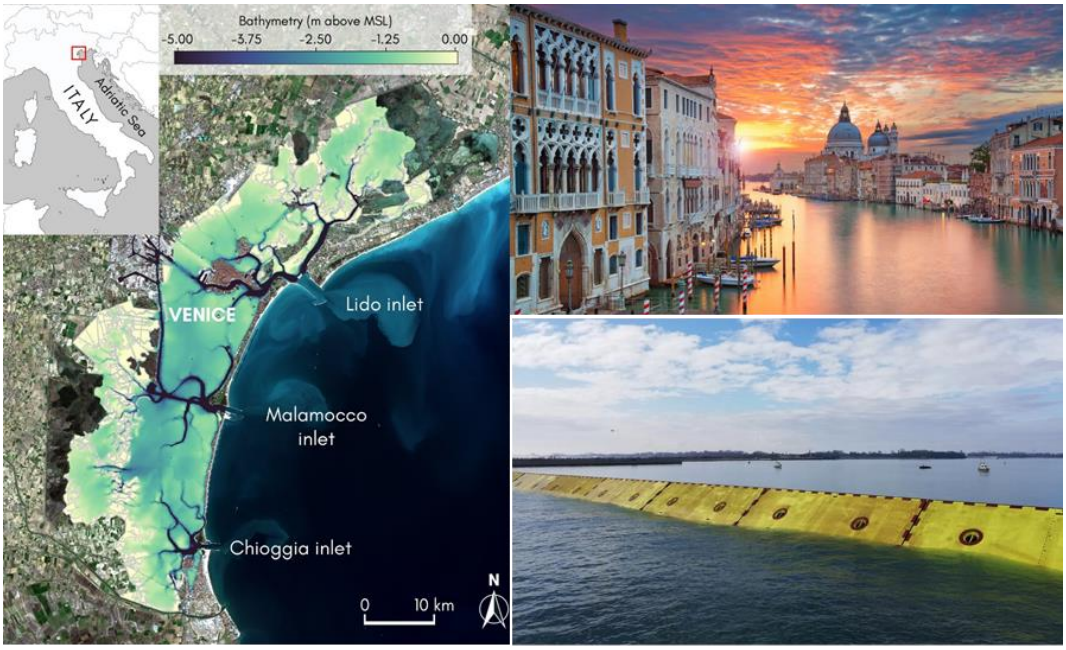

Figure 2. Venice and its Lagoon. Protected by a system of movable gates known as MoSE, Venice faces the challenge of rising tides, while the Venice Lagoon is experiencing accelerated morphological erosion of the lagoon and its vital salt marshes.

The **main goals** of the project are to:

i) **Quantify** salt-marsh ecosystems' **capacity** to **sequester carbon** and improve understanding of what makes them effective carbon sinks;

ii) **Highlight** the often **underestimated value** of **blue carbon ecosystems**, which generate long-term benefits that can offset conservation costs.

iii) Assess the potential negative impacts of coastal flood prevention measures (e.g., storm-surge barriers) using Venice as a case study to develop tailored solutions.

Expected Results. Within the project the PhD candidate will:

i) Use interdisciplinary methods to **study blue carbon dynamics** and identify key factors such as sea-level rise, soil accretion, primary productivity, and biodiversity—that drive carbon sequestration;

ii) Determine the **monetary value of marsh carbon sequestration** over time, incorporating changes in marsh storage capacity and price dynamics of European Emission Allowances and carbon derivatives;

iii) Offer practical guidelines and **policies for the sustainable management of coastal cities**, balancing human needs with environmental conservation.

Funding: "DOR - D'Alpaos"; "FINAC – D'Alpaos"; PRIN2022 eCapture – D'Alpaos"
Possible Collaborations: University of Antwerpen (Belgium); Boston University (USA)